FLEX CEUs

Shockwave Therapy

Introduction

Extracorporeal shockwave therapy (ESWT) is a modality with a wide variety of uses since the 1970s. It was first used for the dissolution of kidney stones and has since expanded in utility to tendon and bone healing. Physical Therapists and Physical Therapist Assistants may or may not be familiar with evidence supporting the practice of ESWT for conditions like tendinopathy as a lot of high-quality research is relatively new. This course will outline evidence-based details of ESWT including indications, contraindications, side effects, parameters, and medical use.

Section 1

Extracorporeal shockwave therapy has a relatively short history. It is a modality that has various uses and specific parameters based on the desired outcome. There are few contraindications and side effects of treatment, making it a safe modality for most patients. There are two types of ESWT including the use of focused and radial waves. Clinicians will learn the history, specifics of the parameters, side effects, and types of ESWT in this section. It is important to be competent in these factors to use ESWT safely in patient care.

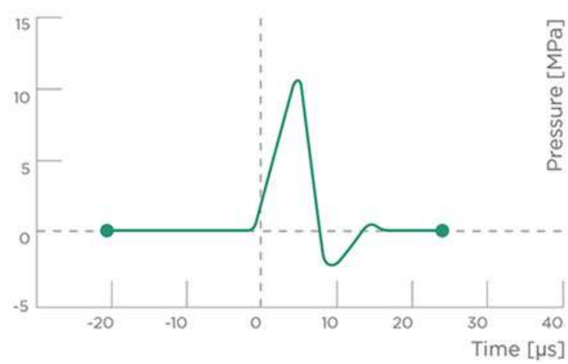
What is Shockwave Therapy? [1–4]

History of Shockwave Therapy

Extracorporeal shockwave therapy (ESWT), more commonly known as shockwave therapy, has a relatively short history to become a medical treatment. In World War II shockwaves were observed to damage the lungs of soldiers who were near waterbombs without being close enough to sustain outer damage to their bodies. Early investigation of the effects of shockwaves on human tissue occurred in Germany. Through various experiments, scientists in Germany discovered in the 1970s that shockwaves with high energy levels could damage human tissue. However, at lower energy, shockwaves would dampen in energy as they pass through human tissue. Muscle and subcutaneous tissue would sustain side effects of shockwaves, and bone would not see any side effects. In 1971, the first outside of the body (extracorporeal) shockwave dissolution of a kidney stone was performed. After more investigation and collaboration with physicians, by the end of the 1970s, extracorporeal shockwave therapy was generally well accepted as a treatment for kidney stones. By 1985 this treatment was expanded to gallstones. Since the 1980s shockwave therapy has grown to the leading treatment for kidney and urinary stones. Shockwave therapy has since been accepted to accelerate the healing of fractures, tendinopathy, fasciopathy, and pathologies to soft tissue.

Shockwave Therapy Explained

Shockwave therapy uses specific fluctuating sound waves to reach deep tissue from outside of the body. Shockwaves occur due to a sudden pressure change and a sound wave that travels faster than the device the wave comes from. The waves have a relatively short time in the rising phase, and they last ten microseconds (0.0001 seconds). While time passes, the wave builds in pressure until it reaches a peak, and then falls in pressure (illustrated below). The shockwave has two phases, a positive and a negative phase, which has differing effects. The positive phase produces waves with high pressure that pass through tissue and either are redirected or absorbed slowly. The negative phase produces air bubbles that burst after the positive phase, resulting in the following pass of small shockwaves. The positive phase is the large peak in the image below which is followed by the negative dip in pressure around 10 microseconds. Shockwaves for kidney stones are delivered through a device called a lithotripter which dissolves the stones to be passed in urination. For orthopedic injuries, the device that transmits shockwaves is called a transmitter probe. The transmitter probe is attached to the main unit supplying the power for the shockwaves.



Mechanism and Parameters [1,5]

Mechanism

After the shockwave exits the transmitter probe it creates several effects on human tissue. These include the creation of new blood vessels at the interface of tendon and bone, increasing the production of tenocytes (assist with the production of new collagen at tendons), increasing growth factor and collagen creation, increasing the number of white blood cells at the site, and assist with the differentiation of osteoprogenitor cells (precursor to osteoblasts). The waves have a few indirect effects on the body which are physical, physiochemical, chemical, and biological. Physically, energy is transferred to tissue via the shockwave producing pressure. Physiochemically, biomechanical reactions occur in response to the physical transfer of energy. This includes the release of adenosine triphosphate (ATP) for energy demand in cells. The chemical effect includes calcium ion mobilization which increases the efficiency of intercellular communication. The biological effect of shockwave therapy allows the creation of new vasculature in the area, lowers inflammation, and allows tissues including bone, muscle, and tendons to heal.

Parameters

Parameters of ESWT are described in terms of energy-flux density. Energy flux density describes the amount of energy transfer that occurs through a specific surface, in this case, the transmitter probe of the shockwave therapy unit. The measurement unit is mJ/mm2 or mega-joules over square millimeters. Categories of intensity are less than 0.08 mJ/mm2 (low), less than 0.28 mJ/mm2 (medium), and less than 0.60 mJ/mm2 (high). The typical therapeutic range in strength is somewhere between 0.001 and 0.4 mJ/mm2, although this varies immensely in the literature. Lower ranges are more successful for pain relief, generation of vasculature, and reducing inflammation. Higher ranges have been successful in treating conditions like pseudoarthrosis when there is a reduction in the production of osteoblasts to heal spinal surgeries. Shockwaves have a large variance in frequency from nearly 150 kilohertz to 100 megahertz. Amplitude in the positive pressure phase rises to nearly 150 MPa (maximum peak amplitude) and falls to nearly -25 MPa in the negative phase. The wave rise time is typically around 300 nanoseconds.

Contraindications and Side Effects [1,6–8]

Shockwave therapy is generally considered to be a low-risk treatment. However, there are a few contraindications that clinicians should be aware of. Patients should not receive shockwave therapy over their abdomen or lumbar spine if they are pregnant. It is acceptable for pregnant patients to receive shockwave therapy anywhere else. Patients with bleeding disorders and clotting disorders should not receive shockwave therapy due to the risk of increased bleeding. Patients with cancer should never receive shockwave therapy. If cancer is in remission and with coordination with primary care or oncology, patients may receive shockwave therapy to promote tissue healing. Clinicians should never perform either type of shockwave therapy over an infection area as it may exacerbate the infection. There is little evidence to support the use of shockwave therapy over the abdomen or chest, so clinicians should not perform shockwave therapy at these sites. It is contraindicated to use ESWT over open wounds, joint replacements, and over pacemakers. Patients with pacemakers can have ESWT done for kidney stones and musculoskeletal treatments if they have single-chamber devices pacing in the ventricles, but settings may need to be adjusted if pacing in the atria. Clinicians who treat patients with implantable devices like pacemakers and stimulation devices should coordinate with primary care and the device manufacturer to ensure patient safety.

Although it is relatively rare, side effects do occur with ESWT. Nearly 21 percent of patients undergoing shockwave therapy will report side effects. One of these includes skin irritation. Patients may communicate they have redness, itching, and mild paresthesia after treatment. Another side effect is pain during treatment and over the treatment area. Very few patients report swelling, bruising, headache, and pain after they receive treatment. These side effects occur in less than 0.5 percent of patients who receive ESWT. Clinicians should educate their patients on these side effects to ensure a comprehensive understanding of what may occur during and after treatment.

Types of Shockwave Therapy [3,9]

There are two main types of shockwave therapy. These include focused shockwave therapy (FSWT) and radial shockwave therapy (RSWT). FSWT involves directing focused maximum pressure at specific tissue. Shockwaves for FSWT can be generated in three ways including electrohydraulic, electromagnetic, and piezoelectric. These methods for generating FSWT are all produced in water as the final target is human tissue, which has a similar resistance as water. Water is contained within the treatment unit, which prevents the waves from losing energy when transferred to human tissue. Focused shockwaves are produced through a coil that uses magnetism to generate force. They are high-energy waves with a fast impulse. Focused waves do not lose much energy on the way to their directed site and very rarely affect surface tissues. These waves release growth factors and nitric oxide due to cavitations from the device. These substances are proven to increase cell growth, create new circulation, and reduce inflammation. Focused shockwaves can reach three times the depth of radial shockwaves and are more accurate over a distance. Focused shockwaves can reach twelve centimeters deep compared to radial shockwaves reaching four centimeters. For this reason, focused shockwaves are most often used for deep structures such as ligaments, deep tendons, and fractures that have not healed. RSWT is typically used for bigger areas and more superficial structures. Radial waves have a slow impulse and relatively low energy compared to focused waves. Radial waves begin with a great amount of energy that lessens as it travels through tissue. Radial waves are made of an ultrasonic and audio acoustic pulse and a slowly traveling shear wave. Radial waves are typically used to treat superficial structures such as lateral epicondylitis, Achilles tendon injuries, and plantar fasciitis. Both radial and focused shockwaves increase the ability of substances to flow to and from cells, increase local circulation through dilation and increased blood to the treatment area, and release substance P (a neurotransmitter that allows increased pain regulation). It is common practice to use both FSWT and RSWT where radial waves are used for the shallow structures that are affected by the injury and focused waves are used for the deep structure that is injured.

Section 1 Key Words

Tenocytes – cells that are between collagen and function to restore and repair tendon tissue

Focused Shockwave Therapy – a type of extracorporeal shockwave therapy that involves directing focused maximum pressure at specific tissue

Radial Shockwave Therapy – a type of extracorporeal shockwave therapy that involves directing ultrasonic and an audio acoustic pulse to superficial tissue to promote healing

Section 1 Summary

Extracorporeal shockwave therapy describes a modality that uses sound waves to treat deep or superficial human tissues. It has been around as a treatment since the 1970s for the treatment of kidney stones and has since been used to treat musculoskeletal conditions. ESWT uses either radial or focused shockwaves which reach superficial and deep structures, respectively. There are relatively few contraindications and side effects, but clinicians should educate patients on these topics to understand what they may expect.

Section 2

Extracorporeal shockwave therapy has several uses in the human body which are evidence-based and appropriate for most ages and patient populations. Patients may benefit from shockwave therapy for the treatment of stones in their urinary system, the gallbladder, pancreas, and for the treatment of reproductive conditions. Patients also benefit from ESWT for the treatment of musculoskeletal injuries and pathologies such as tendinopathy and poor healing fractures. Each of these conditions requires specific parameters for therapeutic effect and treatment produces very few side effects. Physical therapy incorporates shockwave therapy as an adjunct to other interventions including manual therapy, strengthening, stretching, and other modalities. This section will integrate all of the uses for ESWT and provide suggestions of how therapists should explain shockwave therapy to their patients.

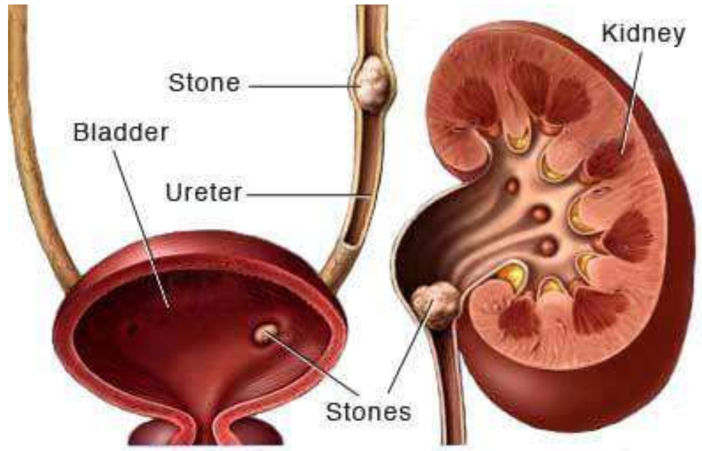
Indications and Patient Populations [1,10–25]

As previously mentioned, ESWT has several clinical uses. It is indicated for the treatment of urologic conditions including problems with the urinary tract and reproductive system, pancreatic duct stones, gallstones, and musculoskeletal injuries. Each of these uses will be described in this section.

Urologic

Nephrolithiasis

Shockwave therapy was first used clinically in the 1970s for the treatment of kidney stones or nephrolithiasis. The process of extracorporeal shock wave lithotripsy (ESWL) involves using shockwaves from outside the body (extracorporeal) to target the stones and dissolve them. There are very few side effects as the shockwaves are directed at the stones and do not impact surrounding tissue. The stones dissolve and are usually easily passed through urine. Lithotripsy is typically used for stones that are less than two centimeters in diameter as they have a great rate of dissolving into passable pieces. Stones exist in either the kidneys or ureters, which can prevent the flow of urine. There is similar efficacy of ESWL and another method called ureteroscopy (laser fragmentation) to break up kidney or urethral stones. ESWL is easier to perform as it is done in an hour procedure without anesthesia. Ureteroscopy takes surgical intervention with anesthesia. Patients typically need to have x-rays taken and lithotripsy is not safe for pregnant patients. The stones typically dissolve within two thousand to nearly five thousand shockwaves, which takes around one hour to perform. Clinicians may repeat treatment from days to months between sessions, depending on the success of treatment and the size of the stone. Up to one hundred and twenty shockwaves are passed to the stone per minute. The strength of lithotripsy is around five to nine kilovolts for this treatment. Patients may have a stent placed from the kidney to the ureter to assist with stone passing. The stone will typically pass within one week to two months. Side effects for lithotripsy are mild and include localized bleeding, infection, low back pain referred from the kidney, and pain while urinating. Overall shockwave therapy is an effective and non-invasive treatment option for nephrolithiasis with few side effects.



Patients at any age are good candidates for ESWL for nephrolithiasis as long as the stone is less than two centimeters in diameter. Extracorporeal shockwave lithotripsy is typically slightly less effective in young children, patients with clotting disorders, and patients who are overweight or obese.

Reproductive

Extracorporeal shockwave therapy is a viable treatment option for erectile dysfunction, chronic prostatitis, Peyronie's disease, and chronic pelvic pain syndrome (CPPS). Shockwave therapy for these indications is typically performed at around ten percent of the strength that lithotripsy requires. For erectile dysfunction, patients receive 3,000 low-intensity shockwaves per week for a month and a half. This protocol has improved erectile dysfunction significantly for nearly two-thirds of patients due to angiogenesis and tissue remodeling. Patients with chronic prostatitis and chronic pelvic pain syndrome benefit from low-intensity extracorporeal shockwave therapy as well. A common protocol is one treatment per week for one month, which has significantly reduced pain and discomfort at a follow-up point of one year after treatment. Patients with chronic prostatitis benefit due to lower inflammation markers post-treatment and improved circulation. Patients with CPPS benefit from around two thousand low-intensity shocks to pelvic muscle spasm or tense areas. Peyronie's disease occurs due to connective tissue hardening around the penis, creating abnormal curving of the penis, pain, and difficulty with erections. Shockwave therapy has been proven to reduce the size of the abnormal connective tissue surrounding the penis and reduce pain. However, the curve of the penis and reproductive function was not restored. More research is needed for specific parameters in the use of ESWT for symptom improvement with reproductive conditions. These conditions typically occur in patients at or older than the fourth decade of life.

Pancreatolithiasis

Patients with chronic pancreatitis are predisposed to stones in the pancreatic ducts (pancreatolithiasis). Patients are at an increased risk of pancreatic duct stones with certain factors including excess alcohol use and chronic pancreatitis. With these conditions, the substance pancreatic stone protein is released at very low levels which increases calcium carbonate deposits in the ducts. Nearly half of patients with chronic pancreatitis have stones in their pancreatic ducts at some point during disease progression. Patients with these stones will experience symptoms of upper right quadrant abdominal pain, a fever, jaundice, vomiting, light stool, and dark-colored urine. Patients with pancreatolithiasis should have the stones removed as soon as possible to avoid complications of poor pancreas functioning like jaundice, diabetes, and poor quality of life. Extracorporeal shock wave lithotripsy is used to dissolve large stones into smaller pieces. At that point, stone fragments can be removed by endoscopic retrograde cholangiopancreatography. If the stones are around ten millimeters or larger, they must be removed surgically. This is rare due to complications and patients typically seek treatment before that point due to symptoms.

ESWL for pancreatolithiasis is performed at any age, but most commonly in adults and elderly patients. This is due to alcoholism and chronic pancreatitis disease progression typically being responsible for the development of stones in the pancreatic ducts. It is uncommon to have these stones early in life.

Cholelithiasis

Patients may have gallstones develop in the gallbladder (cholelithiasis) which can travel to the bile ducts. Gallstones are either removed via an endoscope and retraction or broken up with ESWL before being removed. Physicians may choose to place stents in the bile ducts to allow the broken-up stones to pass effectively. Physicians may also recommend gallbladder removal if the stones are recurrent and if the gallbladder is not functioning properly. Extracorporeal shockwave lithotripsy is used to dissolve stones if the organ is still functional and if patients are not a candidate for gallbladder removal surgery. Patients with recurrent stones are at risk for acute cholecystitis when a collection of stones block the main ducts of the gallbladder. Choledocholithiasis can also occur if gallstones travel to the common bile duct and affect liver functioning. Both of these scenarios are serious and require surgical intervention to prevent poor quality of life, intense pain, jaundice, and systemic infection.

The removal of gallstones via extracorporeal shockwave lithotripsy is generally indicated for elderly patients who have a functioning gallbladder and are at risk for complications from cholecystectomy. It is more common for people to develop gallstones during or after the fifth decade of life. They can develop in children and young adults, but this is much rarer. Physicians will often opt to remove the gallbladder in younger patients who are good candidates for surgery than opt for ESWL to prevent a recurrence.

Musculoskeletal

Patients with several musculoskeletal pathologies and injuries may benefit from extracorporeal shockwave therapy. This is true for athletes across the lifespan, active adults, and patients at any age who have overuse injuries. Some of the common conditions treated are tendinopathies, medial tibial stress syndrome, adhesive capsulitis, plantar fasciitis, femoral head avascular necrosis, knee osteoarthritis, and poor healing long bone fractures. Common tendinopathies treated with ESWT include elbow tendinopathy, Achilles tendinopathy, plantar fasciitis, patellar tendinopathy, and rotator cuff tendinopathy. Tendinopathies occur due to gradual failure and overuse of tendon units from muscle to bone throughout the body. Over time, the tendon begins to degenerate as pain, edema, and inflammation surround the area. Patients will report symptoms of burning pain, inability to move a joint effectively, weakness, crepitus in joints, skin redness, and edema. Tendinopathies are treated in many ways, including medication to reduce pain and inflammation, activity modification, strengthening of surrounding muscle groups, and modalities like ultrasound and electrical stimulation. Shockwave therapy has proved an effective adjunct to other rehabilitation methods due to its ability to increase local circulation, to direct waves to the depth of targeted tissue, to reduce pain, and to improve inflammatory response for healing. For the indications of long bone fracture healing, osteoarthritis, and avascular necrosis, ESWT can stimulate bone healing by regulating bone turnover molecules such as vitamin D3 and parathyroid hormone. This produces an environment where the bone is no longer degenerating, it has a healthy environment to maintain its current state or even begin regeneration. There are specific parameters and evidence proving shockwave therapy as effective for tendinopathy and bone healing, which will be described in the following sections.

Neurologic

Spasticity

Shockwave therapy has also been used for spasticity among patients post cerebrovascular accidents. ESWT proves to be a safe and effective treatment for spasticity with little to no side effects. Protocol averages a frequency of 7 Hz, energy level starting at 0.03 mJ/mm2, 1500 shocks per session weekly for up to one and a half months to the spastic muscle. Most studies have used radial waves to affect a larger treatment area. Muscles that have been treated with ESWT include the triceps surae, flexor carpi radialis and ulnaris, biceps brachii, subscapularis, and finger flexors, which all had a reduction in spasticity. Post-treatment, functional outcomes, pain levels, independence, and motor function were all significantly improved via objective measures including the modified Ashworth scale of spasticity.

Polyneuropathy

Polyneuropathy occurs when nerves in the peripheral nervous system stop functioning effectively. It can be a result of systemic disease including cancer and diabetes mellitus. ESWT conducted for polyneuropathy has been proven to increase circulation to the affected nerves and quicken healing. Sessions are completed weekly for around one month to see results of increased sensation and healing to the poorly functioning peripheral nerves. ESWT improves nerve conduction and volitional movement with just 300 impulses, 0.1 mJ/mm2 of energy, a frequency of 3 Hz, per session. This area continues to be researched and shows promising results for the future of treatment for polyneuropathy.

Clinical Benefits and Duration [4,26,27]

As briefly mentioned previously, many benefits of shockwave therapy are understood. The cumulative therapeutic effect is not well understood, however. Several theories conclude that shockwave therapy at the target tissue produces small traumas that trigger a direct response. This response includes the creation of new vasculature to heal the tissue affected by the shockwaves, to produce new bone-building factors, to generate an inflammatory response, to stimulate the creation of new collagen, to dissolve calcium deposits after tendon trauma, to regulate Substance P (pain mediator), and to relax trigger points. The body forms new blood vessels at the treatment site as a result of direct small traumas to the bone and tendon and the upregulation of growth factors. This new vasculature allows more nutrients and oxygen to reach the damaged tissue for healing. An increased inflammatory response occurs directly after ESWT due to the direct impact of acoustic waves on tissue. This inflammatory response peaks with the release of substances of chemokines and cytokines, followed by reduced inflammation as time passes. This essentially resets the chronic inflammation in the area, with a preferred acute response so that the overall inflammation markers decrease in the area and allows for healing. The synthesis and organization of collagen are stimulated due to the upregulation of tenocyte cellular activity. This allows tendon healing, improved structural integrity, resulting in appropriate collagen organization and strength. Calcium deposits exist when tendons have undergone microtrauma and degeneration. Shockwaves essentially break these up and allow the deposits to be reabsorbed by surrounding lymph vessels for elimination. ESWT also affects Substance P, which is a neurotransmitter related to unrelenting, chronic pain communicated by C fiber nerves (unmyelinated, slow traveling response that communicates sensory pain information). Essentially, the acoustic waves from the shockwave therapy unit decrease the amount of Substance P released, which allows pain relief by less communication to the C nerve fibers. Lastly, trigger points or bound-up muscle tissue at the sarcomere level, are impacted by ESWT. Energy from the acoustic shockwaves is theorized to stop the action of calcium in muscle contraction, which allows relaxation at the individual sarcomeres. This allows the restoration of circulation and normal muscle function at the cellular and somatic levels.

The most common duration of treatment for tendinopathy to see clinical effects is three to five treatments which are spaced on average one week apart. The treatments are focused on specific tissue and only take five minutes on average. For bone growth stimulation and fracture healing, shockwave therapy is completed weekly for an average of three to four weeks. It takes an average of six months to see a 75% success rate in healing nonunion fractures after ESWT for around one month.

Application and Integration into Physical Therapy [26,28,29]

As true with most injuries and rehabilitation, modalities should never be the only treatment approach. Most of the musculoskeletal indications for ESWT include chronic tendinopathy and poor bone healing. These pathologies require a comprehensive examination of the lower or upper quarter and the spine. They require a treatment plan including mobilization of joints and soft tissue, therapeutic exercise, education, and home exercise programs.

For upper extremity pathologies such as rotator cuff tendinopathy, lateral or medial epicondylitis, subacromial impingement, and calcific tendinitis, physical therapists should examine upper extremity strength, range of motion, joint mobility of the upper extremity and spine, the integrity of the nervous system, and posture. Once a hypothesis is formed of tendinopathy in the upper extremity, therapy should include a comprehensive plan of care including mobilizing the nearest joint based on capsular restrictions to normal function, range of motion, strengthening and activation exercises, neuromuscular facilitation of muscles that are poorly contracting, and modalities as appropriate. All upper extremity injuries and pathologies often need treatment at the cervical and thoracic spine due to the regional interdependence of the area. With the addition of ESWT on average, three times per week to traditional physical therapy including strengthening and muscle reeducation, pain, quality of life, and functional use of the upper extremity improves significantly. Things like decreased use of pain medication, other modalities like electrical stimulation, avoiding the chronic phase of pain, and kinesiotape as a successful adjunct treatment are also reported. Kinesiotaping is theorized to improve muscular and nervous feedback, improving appropriate kinematic function. For lower extremity tendinopathy, ESWT should be similarly implemented in physical therapy as with upper extremity tendinopathies. Physical therapists should conduct a thorough lower quarter examination including posture, gait analysis, range of motion and strength of lower quarter muscles and joints, spinal mobility, and any appropriate special tests. Based on these results, therapy should include activation, strengthening, and range of motion exercises designed to correct muscle imbalances while not worsening the pain from the area of tendinopathy, joint mobilizations, gait training as appropriate, and any modalities for pain control. Several studies have concluded that ESWT is a safe and effective adjunct to traditional physical therapy for lower extremity tendinopathies and is effective with just six treatments spaced one week apart.

Therapists should be educated on what a patient will feel during and after treatment. Patients will have a varied experience with treatment experience for ESWT. During the first couple of treatments, patients may experience a loss of sensation around the treatment area or light pain as the shockwaves pulse at the skin. Patients may then feel residual pain for days after treatment that feels like a dull, throbbing pain. Therapists should educate their patients to avoid strenuous activity and nonessential exercise to the affected area for a few days to allow the acute healing response to occur that is stimulated by the shockwave therapy. Shockwave therapy will take a few weeks to months to see long-term results and patients need to be educated on being patient, avoiding activities that exacerbate the target area healing. For example, if Achilles tendinopathy is the target area, patients should avoid running, jumping, prolonged standing, stair climbing, and calf exercises.

Evidence for Musculoskeletal Conditions [8,20,29–32]

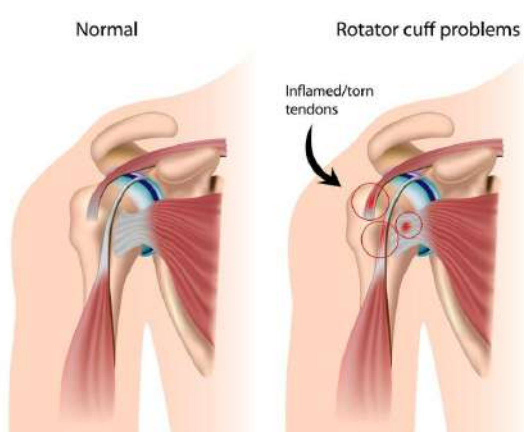
Several studies have examined the effectiveness of ESWT on musculoskeletal recovery. The effectiveness of lithotripsy for kidney, pancreatic, and gallstones is outlined above, and this section will focus on musculoskeletal syndromes. For all syndromes treated by ESWT in the musculoskeletal system, this therapy was found to produce positive outcomes in 89 percent of cases.

Well Supported Conditions

Plantar Fasciitis

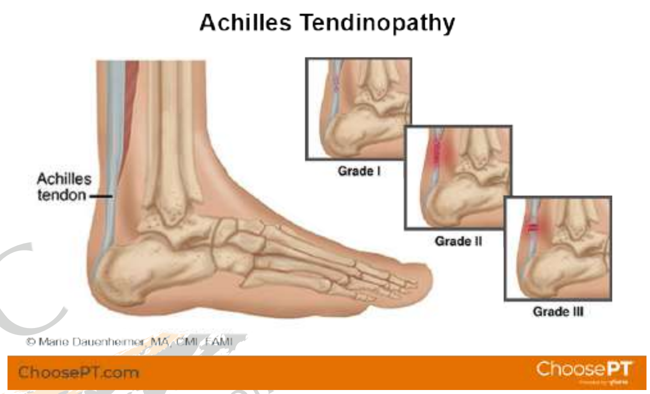
Plantar fasciitis is a condition where patients report pain at the plantar surface of the foot, likely at the site of the insertion on the calcaneus. ESWT in plantar fasciitis has the most research and highest quality evidence to support its use. Risk factors are repetitive work activities, obesity, and overuse. Patients will report pain that is worst in the morning or after periods of activity, with running, walking, and prolonged standing. The average age of patients suffering from plantar fasciitis is between the fourth and sixth decade of life. In treating plantar fasciitis, success rates of using ESWT are reported at up to 94 percent. ESWT is a safe treatment option for plantar fasciitis due to low side effects. Rare short-term side effects include pain during and after treatment, swelling, bruising, and a throbbing feeling. Parameters for ESWT for plantar fasciitis vary from low dose intensity of RSWT at 0.1 mJ/mm2 and 2,000 shock waves three sessions every two weeks, to high dose intensity of FSWT at 0.64 mJ/mm2 with a nerve block and one session at 3,500 shockwaves.

Elbow Tendinopathy



Elbow tendinopathy includes lateral and medial epicondylitis. Lateral epicondylitis, tennis elbow, occurs from overuse and irritation to the common extensor tendon and pain with wrist and finger extension. Medial epicondylitis, golfer’s elbow, occurs due to overuse and inflammation of the common flexor tendon, causing pain with wrist and finger flexion. Shockwave therapy treats these conditions by increasing local circulation and decreasing inflammatory factors. Parameters that produce pain relief include 21 Hz and 2000 shocks to 15 Hz and 1500 shocks per session. Within three shockwave therapy sessions, in a study, the mean of 117 patients with elbow tendinopathy reported significantly improved pain and quality of life even after one month of follow-up.30 These results were reported with negligible side effects and in the age group of the fourth to the sixth decade of life.

Achilles Tendinopathy



https://atr-stl.com/rotator-cuff-tendinopathy/

Achilles tendinopathy occurs with excess use and degeneration of the Achilles tendon, either at the midpoint near the gastrocnemius muscle or the insertion at the calcaneus. It affects people most often in midlife, around age 50, and causes pain with activities like walking, prolonged standing, and stair negotiation. ESWT has been used successfully in treating Achilles tendinopathy. From a protocol of three to four shockwave treatments at 3000 shock waves per session and 15 to 20 Hz of frequency, patients had improved quality of life, functional use of their Achilles tendon, and pain by significant levels.[30] This remained true at one month of follow-up. It has been proven that ESWT is similar in efficacy to eccentric loading for mid-point Achilles tendinopathy and superior to eccentric loading for insertion point tendinopathy.[28]

Rotator Cuff Tendinopathy

Tendinopathy to the rotator cuff occurs due to the accumulation of small tears to the four rotator cuff muscles (supraspinatus, infraspinatus, teres minor, and subscapularis), due to improper repetitive use of the muscles. As with other tendinopathies in this section, with a frequency varying from 15 to 21 Hz using 1500 to 2000 shocks, patients experienced significantly lower pain levels and had improved quality of life and functional use of their shoulder after four treatments.[30]

Greater Trochanteric Pain Syndrome

This syndrome occurs due to wear of the tendons of gluteal muscles and the bursa and causes pain lateral over the greater trochanter, worsened by lower extremity exercise and stair negotiation. The general protocol for greater trochanteric pain syndrome is one to two treatments of either focused or radial ESWT at varying intensities per week for a month significantly improved pain and function. Moderate evidence suggests that ESWT is more effective than steroid injection for pain control and return of hip function one year later.

Patellar Tendinopathy

Patellar tendinopathy also can be treated by ESWT. Of all the conditions mentioned in this section, patellar tendinopathy has the weakest evidence in improving functional outcomes with ESWT. This is partly due to future research needed on the parameters of ESWT for this condition. Based on current evidence, ESWT is no more effective than traditional physical therapy or pain management alone for treating patellar tendinopathy.

Knee Osteoarthritis (OA)

Knee OA, or wearing of the cartilage between the femur and tibial articulation, is one of the most common orthopedic conditions in patients from midlife to the elderly. ESWT is effective in treating pain and dysfunction associated with knee OA. The best parameters are a total of three to six sessions performed on average four days apart, with 2500 shocks per session at 12 Hz of frequency. Functional outcomes included decreasing stiffness by nearly fifty percent and eighty-five percent of patients improving significantly. Knee OA is a progressive condition and may not respond to ESWT forever, but it is an important treatment to consider to restore quality of life before a knee replacement is needed.

Long Bone Fracture

ESWT can be used after surgery for the stabilization of a long bone fracture. When applied at an energy flux density of 0.55 mJ/mm2 and 3,000 shockwaves, substance levels for healthy bone growth are regulated. These include vitamin D3, parathyroid hormone, and Type 1 collagen markers. Osteoblast production is also stimulated while osteoclast production is limited. This promotes bone healing due to the function of osteoblasts healing bone and osteoclasts breaking bone down. This has large implications for healing fractures in the elderly or osteoporotic population as this population is most susceptible to fractures and poor healing due to low bone density.

Section 2 Key Words

Nephrolithiasis – describes kidney stones which are typically made up of calcium deposits

Endoscopic retrograde cholangiopancreatography – a procedure to gain sight of blockages or other pathology in the liver, pancreas, bile ducts, and gallbladder using an endoscope

Pancreatolithiasis – describes the presence of stones or collections of calcium carbonate within the pancreatic duct

Cholelithiasis – describes the presence of stones or calculi in the gallbladder

C nerve fibers – sensory nerve fibers that respond to intense pain with slow traveling signals due to being unmyelinated

Modified Ashworth Scale – an objective outcome measure that assesses muscle tone with passive range of motion

Substance P – a neurotransmitter that regulates pain tolerance by mediating nerve pathways

Sarcomere – an individual unit of muscle contraction including one myofibril and perpendicular structures ending the unit, called Z lines

Regional Interdependence – the relation of pain and dysfunction in two areas that are close in anatomical areas

Section 2 Summary

As outlined in this section, extracorporeal shockwave therapy has a variety of uses ranging from dissolving kidney stones to improving function with tendinopathy, with mostly positive clinical outcomes. Although they vary, physical therapists and physical therapist assistants should be well versed in the parameters and indications for tendinopathies, as these are the most common conditions treated in the clinic by rehabilitation professionals. ESWT is safe and effective for patients across the lifespan and accompanied by minor post-treatment effects including numbness and dull pain.

Section 3

ESWT in clinical practice has its benefits and challenges with implementation. There is no formal certification for therapists, but they need to take continuing education on using a shockwave therapy unit. Access to ESWT can be limited based on cost and access to the service. ESWT is covered under insurance for some uses, and not for others. This section is bound to change as access to the modality and research continues to improve, allowing it to be more supported and reimbursed by insurance.

Certification Process and Access [33]

There is no formal certification required to perform ESWT as a therapist. However, it is highly recommended that therapists attend a continuing education course which is typically four hours in length to be well educated in this clinical practice. Physicians only typically perform focused shockwave therapy for bone healing. Various continuing education classes are offered for Physical Therapists and Physical Therapist Assistants based on the manufacturer's specific ESWT device. The ESWT device may vary in whether it produces radial or focused shockwaves, the energy level, and frequency. The operator must understand the specific device to avoid side effects and produce the desired therapeutic effect of the machine. Access to ESWT can be a challenge as the individual units can cost thousands of dollars. Small private practice clinics and rural areas may not have these units available. Also, patients may not be able to afford the treatment.

Insurance Coverage [34]

Extracorporeal shock wave lithotripsy is covered under Medicare, Medicaid, and most major insurances for urinary tract kidney stones and gallstones. This treatment has been around for decades and is the leading medical management strategy for kidney stones. Insurance reimbursement is approached differently for ESWT of musculoskeletal conditions, however. Over the past five to ten years, there has been an increasing amount of evidence supporting ESWT and its use for the treatment of tendinopathies. Most of this evidence has concluded that ESWT is a safe and effective treatment for chronic tendinopathies with equal or better results than other treatments. However, conclusions made for conditions like Achilles and patellar tendinopathy have not made the strongest cases in the effectiveness of ESWT on healing compared to less expensive treatments. Medicare and Medicaid per CMS guidelines do not reimburse ESWT for musculoskeletal indications as they consider ESWT "not reasonable and necessary for the treatment of musculoskeletal conditions and therefore not covered" starting in February of 2021.35 Insurance companies in the United States like United Healthcare and Blue Cross Blue Shield have followed the guidance of Medicare and also do not cover ESWT for musculoskeletal conditions. This may change as more evidence is published supporting the use of ESWT for tendinopathies. The US Food and Drug Administration does not limit the use of ESWT and has stated it is safe for use for musculoskeletal indications.

Section 3 Key Words

CMS – Centers for Medicare and Medicaid Services which is a federal agency responsible for the regulation of Medicare and Medicaid policies

Section 3 Summary

Although much of this course has discussed the benefits and drawbacks of ESWT as a clinical tool, it may not be incredibly accessible to patients based on cost and geographical area. The literature suggests that as evidence builds for the efficacy of ESWT on tendon healing, access will expand based on cost, insurance reimbursement, and clinic availability.

Section 4

Case Study

Rachel is a 54-year-old female who has been experiencing chronic foot and heel pain. She states it is worst in the morning and during her workday at her standing desk. She has tried wearing orthotics and icing her foot daily, but the pain continues despite these strategies. She is unable to complete her daily exercise which is hiking and running.

Reflection Questions

1. What diagnosis is likely given the information above?

2. What should a Physical Therapist examination include?
3. What treatment modalities may be effective in treating plantar fasciitis?
4. What parameters would help treat this patient with ESWT?
5. How often should this patient receive ESWT to see clinical efficacy?
6. What may a patient feel during and after ESWT?

Responses

1. Plantar fasciitis
2. A comprehensive lower quarter examination including posture, strength and length of muscles, joint mobility, gait analysis, and palpation of the foot and heel.
3. Ultrasound, electrical stimulation, and extracorporeal shockwave therapy.
4. Parameters for ESWT for plantar fasciitis vary from low dose intensity of RSWT at 0.1 mJ/mm2 and 2,000 shock waves three sessions every two weeks, to high dose intensity of FSWT at 0.64 mJ/mm2 with a nerve block and one session at 3,500 shockwaves.
5. On average, one treatment per week for around one month at the correct parameters should produce positive results. These results may take one to two months to notice to allow for the acute healing process of the fascia to take place.
6. Patients may feel pain and a throbbing sensation during and after treatment. The area of focused treatment may become slightly numb, which should stop right after or shortly after treatment. Patients should not perform any strenuous activity in the area for a couple of days after treatment.

Conclusion

Extracorporeal shockwave therapy has a variety of clinical utility including lithotripsy of kidney and gallstones, tendinopathies throughout the body, and bone healing. There are very minimal side effects of treatment and it has overall been proven to produce favorable outcomes of increased function and decreased pain for upper and lower extremity tendon pathologies. Every provider performing ESWT should be well educated on the indications, contraindications, side effects, and expected duration of treatment to best serve their patients. Physical Therapists and Physical Therapist Assistants are among these providers and should undergo continuing education to become competent in ESWT practice.

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